Volume XXV Number 3

BULLETIN

OF THE

DEPARTMENT OF AGRICULTURE

STATE OF CALIFORNIA

Sacramento, California : : : July, August, September, 1936

CALIFORNIA MICROLEPIDOPTERA X

By H. H. KEIFER, State Department of Agriculture

WHILE drawing up the figures and description for the Tomato Pinworm, *Gnorimoschema lycopersicella* (Busck), which were published in the last installment (California Microlepidoptera IX— Mo. Bul. Cal. Dept. Agr. Vol. 25, No. 2, p. 235, issued June 17, 1936), I found that the series which originally had been considered as entirely this one species could in reality be separated into two distinct series. This separation was made on the basis of both color and structure, the color and size differences being discernible to the unaided eye in the majority of specimens. Of the resulting two groups, one was represented by adults reared from tomato and potato, and also by light-trap specimens collected in Southern California. This group exactly matched Mr. Busck's figures of the genitalia of *lycopersicella*.

The second group was almost entirely composed of individuals reared from native *Solanums*. These averaged larger and darker than the typical *lycopersicella*, and possessed genital structures distinctly and consistently different from the pinworm. Moreover, the range of this moth on native *Solanums* has proved to be much greater than the California area in which pinworm damage to tomatoes occurs. Thus there seemed to be sufficient evidence that this darker species was native in the state, whereas the true pinworm had entered California from some point to the south.

Accordingly, I presented the case to J. C. Elmore, U. S. Bureau of Entomology, Alhambra, who has been very generous in placing at my disposal the bionomical data which he possessed on this problem. He also undertook several breeding experiments which are reviewed below. Therefore, I take pleasure in naming the native moth for Mr. Elmore.

Gelechiidae

Gnorimoschema elmorei Keifer, new species

Gnorimoschema lycopersicella Keifer (not Busck) Mo. Bul. Cal. Dept. Agr. Vol. 20, p. 625, 1931(Nos. 10–11, issued Jan. 1932).

Expanse 7 to 13 mm. Palpi generally infuscated, with white scale-tips; second joint with a white central spot or transverse band outwardly, white to rear on inner side, lighter at tip; terminal joint spotted white in middle and just below tip. Face shining cream-white, dark at sides; head above infuscated, with scales tipped white; antennae infuscated. Thorax as head above and its apex and those of tegulae slightly ochreous. Forewings generally infuscated, giving a decided gray cast to the wings when viewed with the unaided eye; some sparse dark spotting throughout and a considerable number of narrow, dull ochreous longitudinal lines. Stigmata hardly distinguished from other dark dots: plical at $\frac{1}{3}$ or beyond with first discal above; second discal at $\frac{2}{3}$; cilia gray. Hindwings light gray, the cilia with an ochreous cast. Abdomen gray above, cream-white below with lateral inwardly oblique dashes on each segment. Legs cream-white, tibiae and tarsi generally infuscated. Male with costal hindwing tuft. Harpes of male genitalia apically forked, the harpe tapering to an acute rounded point with the side-fork projecting at an angle and basally broad; anellus with central ventral lobe as long or longer than side lobes. Female terminalia with sclerotinized section of ductus bursae from ostium approaching line joining apices of anterior apophyses.

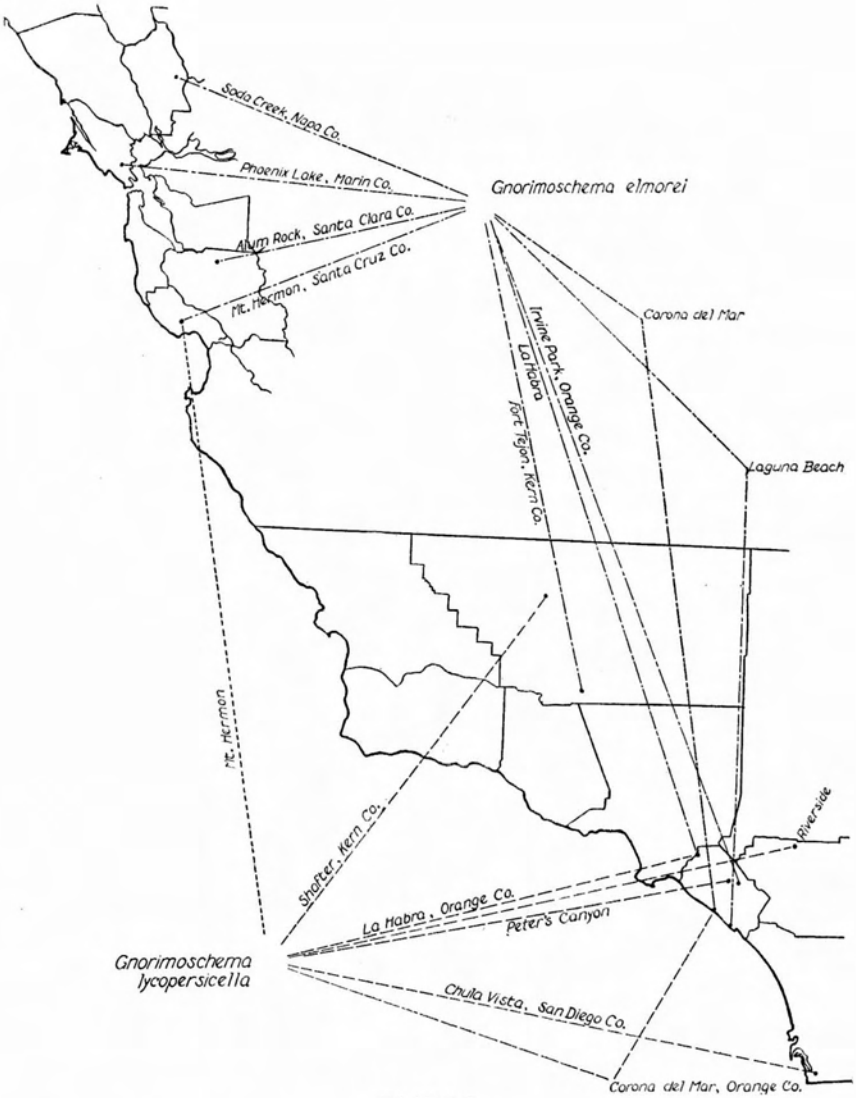

PLATE I

Map showing localities from which specimens were taken on which the studies of *Gnorimoschema lycopersicella* and *elmorei* were based. The Jamesburg and Gigling localities do not appear but are on the coast just on the opposite side of Monterey Bay from the Mt. Hermon locality. For further explanation of the *lycopersicella* localities see California Microlepidoptera IX.

Type, male, collected April 2, 1936, as larva on *Solanum xantii* Gray, at Phoenix Lake, Marin County, the adult emerging May 2, 1936. Allotype, female, same data, larva collected June 8, 1936, the adult emerging June 21. Fifty paratypes are designated from the same location. I first discovered the species in this spot in January, 1927. Other localities represented by specimens on hand are: Mouth of Soda Creek Canyon, Berryessa Valley, Napa County, April 5, host—*Solanum xantii*; Alum Rock, Santa Clara County, February, host—*Solanum xantii* (?), H. J. Lowe, collector; Mt. Hermon, Santa Cruz County, September 10, host—*Solanum xantii* (?); Gigling and Jamesburg areas, Monterey County, June 1 and 5, host—*Solanum umbelliferum* Esch.; Fort Tejon, Kern County, April 16, host—*Solanum xantii* (?); La Habra, Orange County, adult collected at light, July 6; Irvine Park, Orange County, April, host—*Solanum umbelliferum*, J. C. Elmore, collector; Corona del Mar, Orange County, April 17, host—*Solanum umbelliferum*; Laguna Beach, Orange County, April 17, host—*Solanum umbelliferum*. Note that all of these localities are in the Coast Range of California where the climate is more or less directly tempered by the ocean. The life zone to which each station could be assigned, with the possible exception of Gigling, is the Upper Sonoran. There is little doubt that this species extends down into Lower California, but its occurrence elsewhere in Mexico is doubtful. Mr. Busck writes that a considerable series of species of *Gnorimoschema* have been named from Mexico. However, there seems to be no possibility at the present time that these designated species will be sufficiently described to allow adequate comparison with the species under discussion.

The new species is distinguished from typical *lycopersicella*, as follows:

lycopersicella	*elmorei*
Expanse of adults averaging less than 10 mm.; largest seen 11 mm.*	Adults with expanse averaging over 10 mm.; largest 13 mm.
General color a dull tan, the palpi with conspicuous light annuli, ochreous lines on forewing bright with light gray between.	General color gray; palpi with suppressed annuli, especially on outer side of segment 2; ochreous lines dull with heavy gray between.
Male genitalia with harpes apically expanded and broadly rounded at tip, the fork narrow at base and lying above and parallel to apical expansion, anellus with median ventral lobe shorter than lateral lobes; aedoeagus with bulbous base.	Male genitalia with apical expansion of harpes tapering to an almost acute point, the lateral fork broad basally and projecting at an angle to apical expansion; median ventral lobe of anellus as long or longer than laterals; aedoeagus long, with oval bulbous base.
Female genitalia with parabolical hood over ostium; sclerotinized section of ductus bursae ending well before line through apices of anterior apophyses.	Female genitalia with semicircular hood over ostium; sclerotinized section of ductus bursae almost attaining line through apices of anterior apophyses.
Pupa with numerous dorsal punctations on abdomen.	Pupa with fewer dorsal punctations on abdomen, slightly larger.
Larva with lateral dark band on head usually broken behind eyes; hypostomal sclerite black anteriorly; central proleg crochets 12-16, broadly broken outwardly. Length up to 7 mm.	Larva with continuous broad, dark band on sides of head; hypostomal sclerite black; central proleg crochets 14 to 18, most larvae with part of prolegs showing a nearly closed ring. Length up to 8 mm.

* Readers will note a discrepancy in the statements of the alar expanse of *lycopersicella* in installment IX, pp. 237 and 238. Mr. Busck's original description gives 9 to 12 mm. Over one hundred California specimens of *lycopersicella* before me, both reared and collected at light, show alar expanses from 7½ to 11 mm.

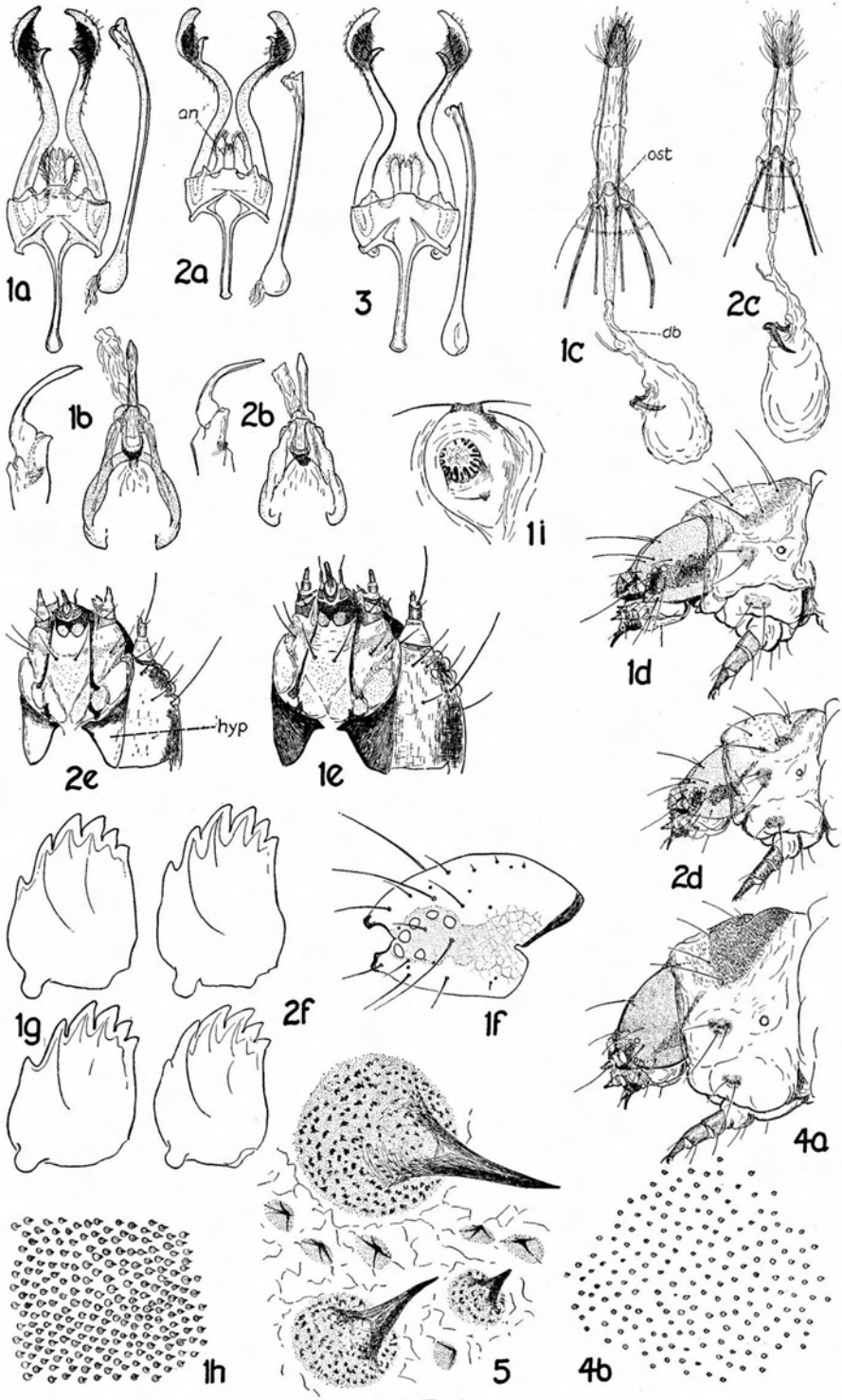

PLATE II

PLATE II

Gnorimoschema elmorei Keifer

Fig. 1a—Male genitalia: harpes, anellus, and vinculum, aedoeagus to right.
Fig. 1b—Male genitalia: left side of uncus to right; uncus, gnathos and tegumen to left.
Fig. 1c—Female terminalia from below; ost—ostium, db—ductus bursae.
Fig. 1d—Larva: Left side of head and prothorax at about 45 diameters.
Fig. 1e—Larval head from below (right side omitted).
Fig 1f—Larva head left side.
Fig. 1g—Larval mandibles.
Fig. 1h—Larval skin spinules at about 650 diameters.
Fig. 1i—Larval proleg, left abdominal showing occasional crochet structure.

Gnorimoschema lycopersicella Busck

Fig. 2a—Male genitalia as in 1a; an—anellus.
Fig. 2b—Male genitalia as in 1b.
Fig. 2c—Female terminalia.
Fig. 2d—Left side of larval head and prothorax at about 45 diameters.
Fig. 2e—Larval head from below (left side omitted); hyp—hypostomal sclerite.
Fig. 2f—Larval mandibles.

Hybrid

Gnorimoschema lycopersicella by *elmorei*

Fig. 3—Male genitalia as in Fig. 1a.

Gnorimoschema operculella Zell.

Fig. 4a—Larval head and prothorax from left at about 25 diameters.
Fig. 4b—Skin spinules at about 650 diameters.

Heliothis obsoleta (Fabr.)

Fig 5—Skin spinules and denticles at about 650 diameters.

The larva of *elmorei* is practically identical with the larva of *lycopersicella* as regards both structure and color, with the exceptions noted in the comparison table above. The skin spinules may show slight differences when studied over the entire body. The color of the hypostomal sclerite is perhaps the most consistent difference, but small *lycopersicella* larvae tend to have this black also. Like *lycopersicella,* the larva of *elmorei* is a leafrolling miner, and possesses the striking purple spots and blotches on the dorsal half of the body. I have collected larvae of *elmorei* in nearly all of the localities listed, but have so far failed to find this larva boring into *Solanum* fruits. The life cycle of the native species requires the same length of time as does the pinworm. So far as known the native species does not hibernate and can be found in the larval or adult or all stages at any time of year. In other words, growth is continuous and death would presumably result if this were seriously interfered with. The Napa County locality indicates that *elmorei* can persist through morning frosts during the winter.

Unlike most taxonomic work, we have been unusually fortunate in this case in being able to study the differences of the two species by means of experimental taxonomy. The data presented here indicate that reproduction by crossing is defective at some point. In other words, the two groups of individuals are closed systems in relation to each other and the characteristics of one group can not be transmitted by inheritance to normal individuals which also possess characters of the other group. This breeding work has, however, definitely correlated the structure and color differences of the two species with the fact that they are functionally distinct. The production of hybrids shows that the differences in genitalic structure are no mechanical barrier to copulation. Therefore, these genitalic differences are but a reflection of the real functional distinctions of the two species, distinctions which are actually not discernible by ordinary taxonomic methods.

Mr. Elmore isolated four pairs of individuals for hybridization, comprising two males and two females of both *lycopersicella* and *elmorei* and confined them with the opposite sex of the other species respectively. One female *lycopersicella* of this series laid fertile eggs April 28 from which males emerged on June 11, and females on June 28, July 1, and July 4. These individuals are larger and darker than the average *lycopersicella,* but have the genitalia more nearly resembling those of *lycopersicella.* The difference in time between the emergence of males and of females illustrates part of the defective bionomy of the hybrids since the sexes of normal generations emerge simultaneously. Mr. Elmore has attempted to breed hybrid males with hybrid females, and also hybrid females with normal *lycopersicella* males; all without success. Side by side with these, pure cultures of *lycopersicella* produced eggs as usual.

In another series of experiments, females of *lycopersicella* are confined with males of *elmorei* on tomato; females of *elmorei* with males of *lycopersicella* on native *Solanum*; and a pure culture of *lycopersicella* on tomato and *elmorei* on native *Solanum.* The pure cultures bred vigorously, whereas the attempted crosses produced nothing.

Mr. Elmore further writes that *lycopersicella* can be reared on native *Solanum*. All collections of larvae from these native plants have, however, so far failed to produce anything but *elmorei*. Adults of *elmorei* confined on tomato will produce some tomato-feeding larvae, so it seems possible that a tomato-feeding strain of the native species could be produced, but there seems little chance of this happening under ordinary conditions. In one case in particular, a tomato field in Orange County, adjacent to heavily infested *Solanum umbelliferum*, failed to develop a heavy infestation of pinworm. An attempt to transfer half-grown *elmorei* larvae from native *Solanum* to tomato failed. All these results show that mere transfer of hosts is not sufficient grounds for determining the validity of species, at least not in this case. The typical pinworm will not feed on Deadly Nightshade, *Solanum nigrum* L., according to Elmore. The native moth has not been collected on *nigrum*.

The quarantine and economic implications of the above lie in the revised conception of the distribution of the pinworm in California and in its relation to native *Solanums*. This study restricts the known range of established *lycopersicella* infestations in this state to Kern County and south.* (I am informed that reinspection of the infested Kern County area, discovered in 1934, now fails to disclose any individuals of *lycopersicella*). (The effect up to the present of the lack of intercounty regulation on the movement of infested material is unknown and could only be established by surveys.) This study also indicates that the pinworm does not have established individuals throughout our native *Solanums* to help it in maintaining existence away from cultivated areas or in spreading to new localities.

Stenomidae

Setiostoma fernaldella Riley

Riley—Proc. Ent. Soc. Wash. Vol. 1, p. 155, 1889.

Dyar—List No. 5536, 1902 (Yponomeutidae).

Meyrick—Genera Iisectorum. F. 164, p. 4, 1914 (Glyphipterygidae).

Barnes and McDunnough—Check List No. 7598, 1917 ((Glyphipterygidae).

Adult 12 to 14 mm. in expanse. Antennae black with white spots along upper side. Head and thorax bright yellow (green over yellow in Southern California specimens). Basal third of forewings as thorax; outer two-thirds deep iridescent purplish-black with raised scales. Hindwings and abdomen blackish-brown. Palpi upturned; brush on joint two longer basally; joint three broad and grooved longitudinally in front. Male antennae long-ciliate. Wing veination as figured. Male genitalia: Uncus a curved spine; gnathos ribbon-like; harpes broad, about as long as uncus, broadly attached at base to tegumen, with a cluster of strong, distally hooded setae from inner antapical knob; aedoeagus broad, tubular, with prominent cornuti; eighth segment with anterior apophyses. Female ovipositor short, lengthened by projection of anterior apophyses and associated plates; no signum.

Pupa 5½ mm. long, brown, surface generally finely crenulate. Labial palpi indicated by a small median sclerite between bases of maxillae; maxillary palpi

* We have just received larvae of *Gnorimoschema lycopersicella* from the Ivanhoe district east of Visalia, Tulare County, collected from tomato leaves, July 16, 1936, by Dr. A. E. Michelbacher of the University of California. This infestation was stated to have been approaching serious proportions. The infested field is located in the foothill citrus district from which there is a winter drainage of cold air. This extends the known pinworm infestations fifty miles north of the Kern County locality. *It should be noted that the moth has not yet appeared in tomato fields north of the* range of certain elements of our native southern flora, notably *Yucca whipplei*, which extends to the Kings River area twenty-five miles north of Visalia.

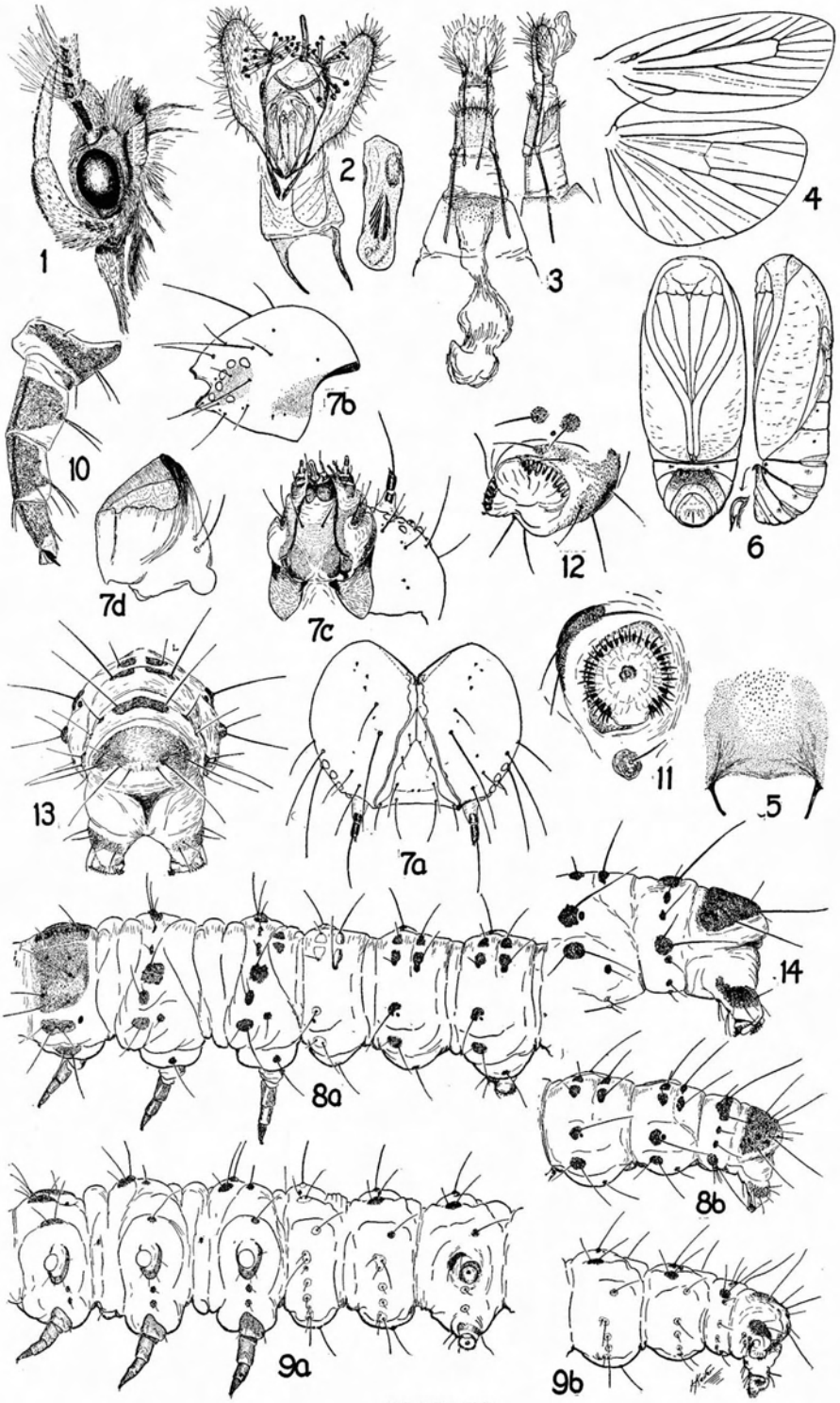

PLATE III

PLATE III

Setiostoma fernaldella Riley

Fig. 1—Adult head, left side.

Fig. 2—Male genitalia, aedoeagus to right.

Fig. 3—Female terminalia, left view to right.

Fig. 4—Wing Veination.

Fig. 5—Anterior sternal plate of adult abdomen.

Fig. 6—Pupa, left side to right; barbed spine lower center.

Fig. 7—Larval head: a—front view; b—left side; c—from below; d—mandible.

Fig. 8—Larva, subdorsal view: a—thorax and first three abdominals; b—last four abdominals.

Fig. 9—Larva, supraventral view, same as in Fig. 8.

Fig. 10—Larval metapod from behind.

Fig. 11—Larvel proleg from left A3, seen from below.

Fig. 12—Larval left anal proleg from below.

Fig. 13—Rear view of last three abdominals.

Fig. 14—Left side of last four abdominals.

almost obliterated. Segments 5, 6, and 7 movable, with lateral condyles in the sutures. Segment 7 with ventral anterior edge produced into a transverse ridge, somewhat knobbed laterally, bearing two or three barbed recurved spines on each knob, and two between. A few small hooked hairs on tenth segment.

Larvae up to 12 mm. in length have been examined. Head light brown, some dark marks. Body dull greenish; thorax red; red dorsal areas on most abdominal segments; two lateral red stripes from rear half of first abdominal segment to tenth; a small red spot with each seta VI. Tubercles large, blackish except the lighter tubercles on segment A1 and below on A2, A7, A8, and A9; prothoracic shield and suranal plate blackish; thoracic legs blackish. Central proleg crochets 38-40, biordinal discontinuous on inner side; anal proleg crochets 20 to 22, biordinal, discontinuous centrally.

Larval structure: Adfrontal sutures not attaining occipital foramen by one-fourth of distance; mandible with about three teeth on outer side, remainder a broad grinding edge. Prothoracic shield subquadrate. Body flattened dorsoventrally, broadest at thorax and tapering; tubercles large, the dorsal tubercles extended and broadened toward the center, an extra pair of non-setiferous sclerites on the last mesothoracic dorsal lobe (postscutellum). Setae Ia, Ib on meso- and metathorax on separate tubercles. Outer apical setae of thoracic legs broad expanded and scale-like. Three setae in position VII on A1, the inner seta on a separate tubercle. Setae I on A9 at ends of a large transverse tubercle extending across mid-dorsum; seta III slender, on small tubercle. There are no setae missing nor are there accessory setae in position VII on any segments.

Larva a leaftier on live oaks, tying two leaves together broadside and forming a characteristic "cell" therein, the cell outlined with a wall of silk and frass. The leaves are skeletonized.

This moth is nowhere common but a few larvae can usually be obtained after several hours' beating on oak limbs in suitable locations. Localities in which I have collected larvae are: Oroville, host—*Quercus wislizenii* A.; Fair Oaks, Sacramento County, host—*Quercus wislizenii*, Deer Creek, El Dorado County, host—*Quercus wislizenii*; Sunland, Los Angeles County, host—*Quercus agrifolia* Nee. Note that these localities are nowhere near the coast. The Sunland location is perhaps the one most modified by ocean winds.

This beautiful moth is as much a taxonomic curiosity among California Micros as it is striking in appearance. The relationships of the genus to which *fernaldella* belongs have been rather uncertain, but Mr. Busck (Proc. Ent. Soc. Wash. 27, 48, 1925) has shown that *Setiostoma* is a member of the large western hemisphere family Stenomidae, of the Gelechioidea. In the present article the pupal structure is shown further to bear out the evidence of Gelechioid relationship not only by the position of the mouthparts and legs but by the lateral condylic articulation of the abdomen. These lateral condyles are found in the pupae of *Stenoma, Agonopteryx, Ethmia, Pyramidobela*, and others. Pupae of *Choreutis* are not of this type and could not be associated with the *Setiostoma* pupa as could the Gelechioid pupae mentioned above. Note that the larva of *Setiostoma* is largest in the thorax, that it is somewhat flattened dorsoventrally, and that there are no accessory setae on the anal prolegs. Accessory anal proleg setae are a regular feature of many species of several Gelechioid families. The larva of *Stenoma sororia* Zell. from Central America, while possessing structures somewhat distinct from *fernaldella*, also lacks accessory setae on the anal prolegs. Judging from Mr. Busck's figure of the male genitalia of *xanthobasis* Zell., this eastern species is not much different from *fernaldella*, except perhaps on aedoeagus structures. Riley stated that the western moth differed in part by the raised forewing scales.

The presence of *Setiostoma fernaldella* in California brings up some interesting questions on the North American distribution of Microlepidoptera. Mr. Busck writing in the Barnes Contributions to Lepidoptera of North America, Vol. 4, p. 238, 1920, states that no species

of *Stenoma* has ever been authentically taken in California. The genus *Stenoma*, one of the largest of Micro genera, and confined to the Western Hemisphere, includes nearly all of the species of the Stenomidae. There is one specimen of a *Stenoma* labeled "Mt. St. Helena" in the Acadamy of Sciences, San Francisco. We, therefore, face the anomolous fact that this large group of moths so characteristic of the New World and well represented in the southern and eastern United States is, with the exception of one species of *Setiostoma* and few if any *Stenomas,* unrepresented in most of California. Undoubtedly species of *Stenoma* will be found in California areas adjacent to Arizona. but these have not yet been properly explored. The above line of reasoning could be similarly carried out on the basis of other Micro groups.

The question has been raised as to the means of larval preparation which determines the style of the larval illustrations included in these papers. The larvae are dropped alive into 70% alcohol, just below boiling point, and allowed to remain until the desired amount of turgidity has been reached, when they are removed. The curvature and wrinkling of the body and head position depend on the time of treatment. Larvae should always be killed in heated liquid to prevent oxidation and resulting discoloration. Larvae dropped into cold preservative almost invariably die in distorted positions and are not suitable for detailed study.

The type and allotype of *Gnorimoschema elmorei* are deposited in the California Academy of Sciences: type CAS No. 4195; allotype 4196.

A *lycopersicella* infestation at Modesto in connection with a greenhouse has been reported under date of August 26 by J. C. Elmore. Two fields were infested.

Lepidium latifolium L., A NEW PERENNIAL PEPPERGRASS.

This peppergrass was collected on the Richards Ranch north of Oakdale in Stanislaus County July 19, 1936, and submitted to the Department for identification. The species is new for California, and so far as we have been able to ascertain this site represents the first known occurrence within our boundaries. According to Milo Schrock, Agricultural Commissioner, the infestation, located in a field of Ladino clover, covers an area of approximately 40 feet. There is a strong spreading perennial root system. *Lepidium latifolium* has the general habit and appearance of Hoary Cress, and could readily be taken for that common species by the casual observer. The pod is rounded in outline, about 2 millimeters in diameter, and flattened, with a few scattered hairs. There is almost no style, the stigma appearing sessile. The lower leaves taper to a rather elongated stem, the upper being sessile. They do not clasp the stem as in Hoary Cress.

At the present time we are unable to suggest how this new and noxious species was introduced. Possibly it has been brought in with commercial seed, its identity and therefore pernicious nature not being recognized. According to Hitchcock's revision of the genus *Lepidium* in the United States, Madroño, July, 1936, *L. latifolium* is introduced along the coast of New England and well established in parts of Mexico.—*M. K. Bellue.*